

RTCA Special Committee 186, Working Group 5

ADS-B UAT MOPS

Meeting #17

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Issues regarding NACv in DO-282

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SUMMARY
This paper discusses problems with implementing the NACv field as defined in DO-282, and recommends that the field be encoded as "unavailable" in UAT equipment that meets the UAT TSO C154 requirements.

Introduction

DO-282 §2.2.4.5.4.10 contains requirements for encoding of the "NACv" information field. Development of UAT equipment has shown this section to contain insufficient guidance, and that even if guidance were given, it would reference information in other RTCA documents that is not sufficient.

Issue 1: Lack of guidance in DO-282

DO-282 §2.2.4.5.4.10 references Table 2-46, partially reproduced here for reference.

Table 2-46: "NACv" Encoding.

NACv (decimal)	Horizontal Velocity Error (95%)	Vertical Geometric Velocity Error (95%)
0	Unknown or ≥ 10 m/s	Unknown or ≥ 50 feet (15.24 m) per second
1	< 10 m/s	< 50 feet (15.24 m) per second
2	< 3 m/s	< 15 feet (4.57 m) per second
3	< 1 m/s	< 5 feet (1.52 m) per second
4	< 0.3 m/s	< 1.5 feet (0.46 m) per second
5	(Reserved)	(Reserved)
6	(Reserved)	(Reserved)
7	(Reserved)	(Reserved)

No guidance is given in the text of the UAT MOPS for how to determine the NACv value. In the absence of a source for the NACv field, and given the lack of guidance, and the discussion of Issue 2 below, it seems proper to declare that NACv is "unavailable", and transmit "NACv = 0" at all times.

Recommendation: Provide a reference in DO-282 §2.2.4.5.4.10 to DO-242A Appendix R.

Issue 2: Guidance found in other RTCA documents

Guidance on determination of NACv was developed originally for DO-260 (the 1090 MHz ES MOPS), where it was called "NUC_R", and appears as Appendix J in that document. This material appears in only slightly modified form (now called NACv) in DO-242A Appendix R. Tables R-2 and R-3 are reproduced on the next page for reference.

Appendix R provides a rationale for determining NACv from the HFOM and VFOM outputs from a GPS receiver. Two cases are given, depending on whether differential corrections (i.e. WAAS or LAAS) are available or not.

**Table R-2: Determining NACv From a GNSS Receiver
Operating in LAAS or WAAS Mode.**

HFOM and VFOM Values	NACv Value
HFOM =1 m and VFOM =5.85 ft	4
(HFOM > 1m or VFOM > 5.85 ft) and HFOM =4.5 m and VFOM =23.3 ft	3
(HFOM > 4m 4.5m or VFOM > 23.3 ft) and HFOM =14.5 m and VFOM =73.3	2
(HFOM > 14.5 m or VFOM > 73.3 ft) and HFOM =49.5 m and VFOM =248 ft	1
HFOM > 49.5 m or VFOM > 248 ft	0

**Table R-3: Determining NACv When Differential GNSS Corrections
Are Not Available.**

HFOM and VFOM Values	NACv Value
HFOM =125 m and VFOM =585	2
(HFOM > 125m or VFOM > 585 ft) and HFOM =475 m and VFOM =2335 ft	1
HFOM > 475 m or VFOM > 2335 ft	0

By comparing the HFOM and VFOM limits for a given NACv value, it is clear that there is a wide discrepancy between the HFOM and VFOM values, depending on whether differential corrections are being used or not. DO-242A Appendix R.4 gives the rationale for computing HFOMv and VFOMv based on HFOM and VFOM, which lead to the velocity accuracy estimates given in Tables R-2 and R-3.

This analysis in DO-242A, Appendix R is based on the assumption that within the GPS receiver, the accuracy of the velocity measurements are correlated with the accuracy of the position reports (See paragraph R.4.1). This is not necessarily the case, since GPS velocity can be determined by Doppler shift measurements as well. So the analysis of R.4, and therefore Tables R-2 and R-3, may not apply to all GPS receivers.

In addition, Section R.1 contains a Note that states that a future version of the ADS-B MASPS will specify the final requirements for NACv. That indicates that any present implementation of the NACv field may be incompatible with the final requirements.

Recommendation: Until the requirements for NACv are finalized in a future version of the ADS-B MASPS, and any unresolved issues regarding derivation of NACv from GPS receiver performance, the NACv field should be encoded as "unavailable" in UAT equipment that complies with UAT TSO-C154.